NASA Activities

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Shuttle-C: Using Existing Systems

THIS ISSUE

The headquarters/center relationship is addressed up front in this month's issue by one who has recently completed a three-month assignment at NASA Headquarters.

NASA engineers turn to the familiar to provide a quick answer to the U.S. need for a heavy-lift booster. Shuttle C promises a fast turnaround and low technical risk for a competitive bridge to space.

NASA, NOAA and other agencies mount up and head north for an investigation of the Arctic ozone layer. Similar studies of the Antarctic stratosphere linked man-made chlorofluorocarbons to the "ozone hole" during austral spring.

Facing the future, Johnson Space Center builds a Space Station Mockup and Training Facility. This is one of a number of projects that will usher the agency into a new era of spaceflight.

Looking at the past, NASA's Kuiper Airborne Observatory helps scientists observe Supernova 1987A, an event that occurred some 170,000 years ago but that just recently became detectable to us. This continuing investigation is helping to create a detailed picture of the birth of matter in one of nature's most powerful events.

"To bravely go where no man has gone before" is the goal of "smart machines" of the future. Q&A talks to NASA Scientist Donald Rosenthal about these doughty future explorers.

Next Month:

Magellan: A return to Venus and planetary exploration.

CONTENTS

Headquarters, the Center, and Professional Development 3
Inside NASA: The Occupational Health Division 4
NASA and SBA Sponsor Technology Transfer 5

Agency Highlights
Shuttle–C: Using Existing Systems 6
Science Agencies Announce Arctic Ozone Investigation 8
Pioneer Orbiter's 10 Years Have Revealed Much About Venus 9

Center Highlights
Grand Opening Gives Glimpse of JSC's Future 10
Kuiper Airborne Observatory Continues Supernova Studies 11
Reverse Flow in Shuttle Plume is Old Hat 12

Departments
Q&A: Smart Machines in Space 13
NASA News Capsules 14
Human Factors 15

About the Cover

An artist's depiction of an efficient way to get to space. Using the basic Shuttle with the orbiter replaced by a cargo element, this vehicle would support a variety of missions, ranging from Space Station assembly and resupply, planetary missions, to Department of Defense activities. Shuttle–C is a heavy-lift launch vehicle in the Energia/Ariane 5 category.

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Headquarters, the Center, and Professional Development

by John F. Stokes, Director for Management Operations, LaRC

John F. Stokes recently completed a three-month assignment as acting director for Institutions in the Office of Aeronautics and Space Technology (OAST) at NASA Headquarters. In this column, he shares some of his impressions from that assignment.

As we have all heard, the Headquarters environment is a difficult one. Much of this is driven by external requirements for which no one can plan. Requests from Congress, the Office of Management and Budget (OMB), the Office of Personnel Management (OPM) and other regulatory agencies drive much of Headquarters on a daily basis. While management works to minimize these surprises, many demands for information simply cannot be predicted. This contributes to the crisis environment that pervades much of Headquarters. This, in turn, results in a reactive rather than proactive mode of operation, since no matter how much planning you do, you will get jerked around beyond your control. Add to this the poor logistics support and poor general housing conditions, and you have a very challenging task to maintain morale and productivity in this environment.

The good news is that the employees at Headquarters are exceptionally hard working and dedicated. I was most impressed with the long hours and willingness to fight the challenge of the environment to get the job done. This is typical of what I found not only in OAST but also in the other organizations.

The second area I wish to address is teamwork. While I believe, particularly since the Challenger accident, strong efforts have been made towards teamwork throughout Headquarters and between Headquarters and the centers, we still have a long way to go. A concern is the absence of center input on major decisions. In some cases, this is driven by the lack of time and effective mechanisms to get communications from the center in the short timeframe the actions require. This is exacerbated by the fact that a growing number of Headquarters employees do not have center experience, yet they are in key decision-making positions, which affect the future of the center from a functional, institutional or programmatic standpoint.

There are some things we at centers can do to alleviate this problem. We need to put more time and energy into working on relationships at Headquarters by frequent communications and visits to Headquarters as well as encouraging—almost to the point of insisting—that our functional and program counterparts from Headquarters spend time at the center. This will develop better and more open communications. Understanding of the other guy's problems is best obtained through personal relationships rather than passing pieces of paper back and forth.

Secondly, we can continue to encourage Headquarters developmental assignments. Langley has always been a supporter of the formal Professional Development Program, but I also believe that targeted six-month assignments—plus or minus three-months—can be of great benefit in developing working relationships.

In closing, I was pleased to find—as I have often heard—that Langley is highly respected at Headquarters for both its technical competence and its management integrity. This is very important to the Center and to me as an individual. Finally, I would like to sum up my three months in Washington in the words of a senior Headquarters official when he reflected upon working at Headquarters, "at the same time, it is both exhilarating and frustrating." ■

"We need to put more time and energy into working on relationships at Headquarters... encouraging—almost to the point of insisting—that our program counterparts at Headquarters spend time at the center."

INSIDE NASA

NASA's Occupational Health Division

"Our vision is to provide NASA with a workforce which functions at its highest possible level of health, well-being and productivity", says Dr. Marshal S. Levine, director of NASA's Occupational Health Division. The Division of Occupational Health is a part of the general management function of the Office of Management. "We work closely with a wide variety of health professional at the field centers to provide services", says Levine.

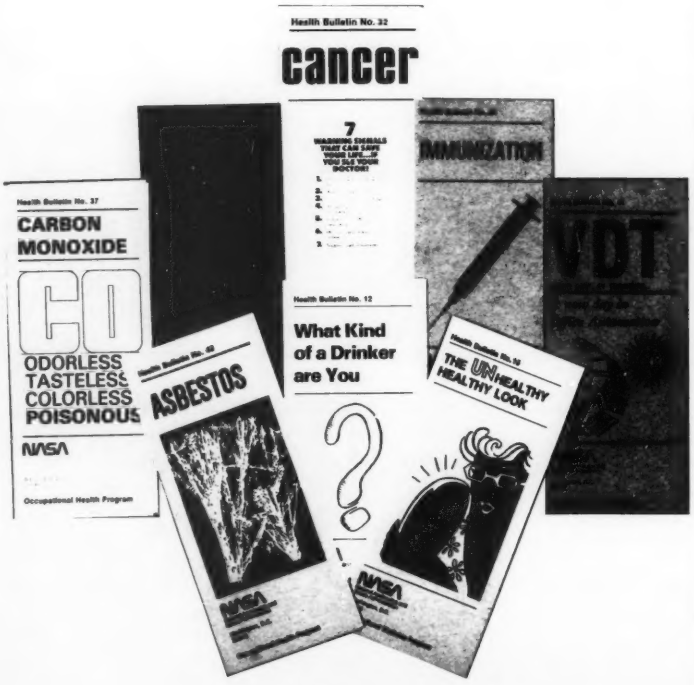
The comprehensive occupational health program represents a unique benefit for NASA employees. Health maintenance physicals, medical monitoring examinations, hearing conservation, blood pressure screening, immunizations Employee Programs (EAP), physical fitness, nutrition counselling, and smoking cessation programs are available. Some centers are now offering mammography which is being evaluated for broader implementation, and other services are under consideration.

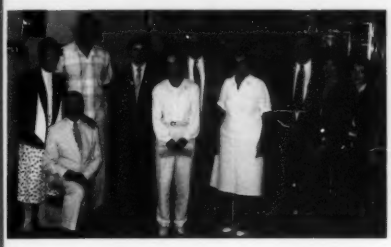
Gene Proctor, manager of environmental health, notes that, "Our efforts at recognition, evaluation and control of noise, radiation and safe drinking water. We are also responding to a number of new legal and regulatory responsibilities including a massive educational effort under the Hazard Communication Laws."

Many of the services are provided at the centers by contractors, under the supervision of contract monitors. The Division of Occupational Health provides the centers with support and guidance by developing performance standards and guidelines, sponsoring professional educational program, presenting an annual scientific meeting, and publishing quarterly newsletters and health bulletins. These efforts are supplemented by annual on-site program reviews. These in-depth reviews demonstrate that the field center occupational health programs continue to be outstanding in the Federal Government, and NASA has recently been recognized for its excellent health and fitness program by the Office of Personnel Management.

...NASA has recently been recognized for its excellent health and fitness program...

A major current effort is the development of an agency-wide computer support system (NOHMIS). This is a joint effort by all the centers to further improve their ability to provide occupational health services and to meet legal and regulatory responsibilities. One exciting new program to be supported by the NOHMIS system will be a health enhancement program. This will provide automated tracking of patient progress in controlling health risk factors, such as cholesterol and high blood pressure, and feedback to both employees and health professionals to promote further improvement in health status.





***Glasnost* NASA style: Deputy head of the Soviet Union's Main Department of Sports For All USSR State Sports Committee, P. Rozhkov, visited NASA Headquarters recently to learn about the U.S. approach to employee fitness. NASA occupational health and clinic personnel, as well as members of the President's Council on Physical Fitness toured the Headquarters physical fitness center. The Soviets also visited other agency and corporate fitness centers.**

The division, in cooperation with the centers, and Code QS, has also been quite successful in controlling injury and disability, and the attendant human and financial cost. Further cost-savings are anticipated as new programs result in improved employee health.

A planning process has been initiated which is aimed at developing a long-range strategic plan. This document will be closely integrated with the strategic plan recently completed by the Office of Management. A yearly program plan will then be developed from the long-range plan.

As the shuttle returns to flight, and as attention is focused on Space Station and Mars, the Division of Occupational Health is well positioned to support NASA with increasingly sophisticated programs. The division and its corps of occupational health professionals looks forward to active participation in this challenging new era. ■

NASA and Small Business Administration Sponsor Technology Transfer Seminars to Aid Minority Business

An interagency agreement recently signed by the National Aeronautics and Space Administration and the Small Business Administration (SBA)provides for co-sponsorship of six technology transfer seminars for minority entrepreneurs, according to Eugene D. Rosen, NASA's director of the Small and Disadvantaged Business Utilization Office. The seminars will take place over a three year period.

An initial seminar was held in late August, in Orlando, Florida. Preliminary indications are that the seminar was very successful. The next seminar is planned for March 5-8, 1989 in Los Angeles.

The seminars are designed to identify technology suitable for commercial use from NASA's Industrial Application Centers and possible subcontracting opportunities stemming from NASA's prime contract awards.

A steering committee has been established from SBA and NASA staff to coordinate and plan the seminars. Members of the committee include Bernita Kane, Small Business and Industry Specialist, SBA; Ray Gilbert, manager of applications and engineering, Office of Technology Utilization, NASA; and Eugene D. Rosen.

The committee will serve as liaison between the two agencies' staff, work with other federal agencies and private sector representatives to identifiy contract opportunities, and select appropriate seminar sites.

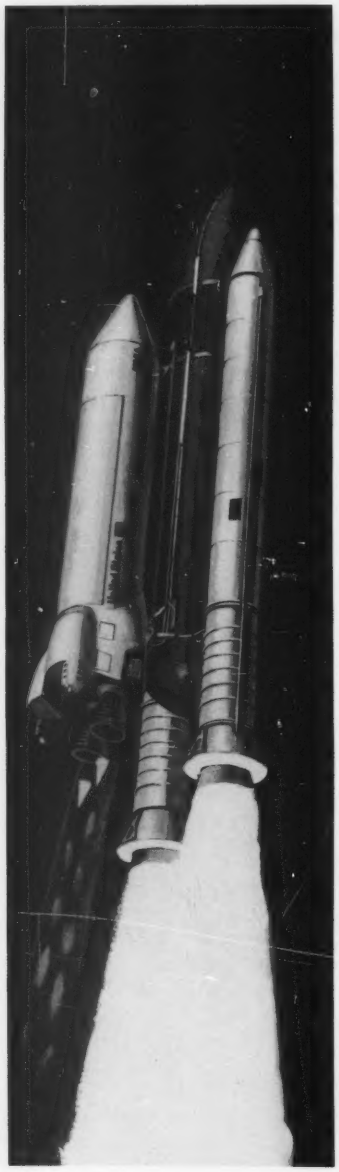
Subject to the availability of funds and other resources, NASA and SBA will participate in cost sharing for seminar facilities, promotional literature and follow-up plans to provide further assistance to firms with the capacity or potential for high-tech developments. ■

"Selling to NASA" helps the entrepreneur understand how to do business with the agency. It includes information about NASA, its procurement process, marketing the business' capabilities, special assistance programs and other helpful information.

AGENCY HIGHLIGHTS

Shuttle-C:

Using Existing Systems to Cut Costs and Improve Access to Space



The National Aeronautics and Space Administration is designing a cargo version of the Shuttle that can give the nation an early heavy-lift capability. Shuttle-C, as this unmanned version is called, is a natural, low-cost evolution of the current Space Shuttle that can be flying 50 to 75-ton payloads within four years.

At the core of the Shuttle-C design philosophy is the principle of enhancing the Space Transportation System. This will hold down costs by taking maximum advantage of existing designs and facilities and will extend the life of the current Space Shuttle fleet.

In itself, the Space Shuttle is a heavy-lift launch vehicle placing more than 230,000 pounds in low Earth orbit on each mission. Much of that mass, though, is wings, heat shield, crew compartment, and other components needed to return the crew and cargo. The current Space Shuttle can deliver about 39,500 pounds of payload to the Space Station orbit (250 miles high). However, many Shuttle payloads do not require a crew, and national launch demands are expected to exceed the lift capability of the Shuttle and other launch vehicles through the end of the century.

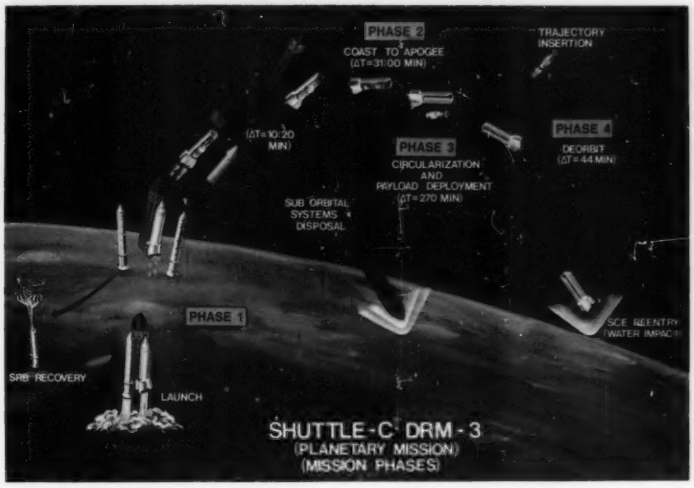
Payloads capability for Shuttle-C to Space Station ranges from a minimum of about 100,000 pounds for the basic version with two main engines to 170,000 pounds with three main engines and the Advanced Solid Rocket Motor (ASRM) planned by NASA. The configuration used depends on the mission requirements.

At first glance, Shuttle-C looks much like the current "baseline" Shuttle but for the wings. Closer examination shows that the vehicle also has no crew cabin, and in some some configurations has two rather than three main engines.

Shuttle-C meshes with the baseline Shuttle design to the greatest extent possible. Ground facilities and the Solid Rocket Boosters (SRB) and External Tank (ET) are used without change. The winged orbiter is replaced by the Shuttle-C Cargo Element comprising a payload carrier and an aft fuselage. Unlike the Shuttle, though, the basic Shuttle-C Cargo Element is expendable.

Shuttle-C would enhance the national space launch capability by reducing the number of launches needed to perform a number of high-priority space missions. For example, launches and assembly time for the Freedom Space Station can be cut in half. A Mars Rover/Sample Return mission could be launched by a single Shuttle-C with a Centaur upper stage instead of two large expendable launchers, each with a Centaur. Shuttle-C/Centaur could also place about 20,000 pounds in geostationary orbit, almost four times the current capability. In addition to enhancing planned missions, Shuttle-C can serve as an unmanned test bed for potential Shuttle upgrades like the Space Transportation Main Engine, and the ASRM.

NASA has been studying Shuttle-C with a contractor team made up of the Space Flight Systems Division of UTC Corp., Martin Marietta Aerospace, and Rockwell International. Because it uses existing designs, the development effort for Shuttle-C is minimal, allowing a first launch within three to four years of authority to proceed.



A Typical Mission

If launched two to three times a year, Shuttle-C can be produced at a steady rate that helps assure low costs. Assembly, integration and launch of Shuttle-C is much like that of the Shuttle today. The payload is installed into the Shuttle-C in the Cargo Element Processing Facility, and the complete cargo element attached to the ET and SRB in the Vehicle Assembly Building.

Launch and ascent are almost identical to the baseline Shuttle, complete with a 90 degree roll after lift-off and pitch-over to fly "heads down". A two-engine Shuttle-C fires for 620 seconds,vs. 520 seconds for the three-engine Shuttle-C and the baseline Shuttle. Except for Shuttle abort options involving a landing, and jettison of the nose cone and shroud on Shuttle-C, all other aspects of ascent are the same as for the baseline Shuttle. The payload shroud is jettisoned after Main Engine cutoff. Orbital insertion is performed by the thrusters in the aft Orbital Maneuvering System (OMS) pods. For missions involving assembly or servicing of large payloads, such as Space Station, the Shuttle-C rendezvous maneuvers are accomplished by the Orbital Maneuvering Vehicle using aft thrusters in the OMS pods and its own thrusters. After deployment of the payload, the Shuttle-C is slowed to place it on a re-entry trajectory over open ocean.

In studies to date, Shuttle-C has been developed against a set of Design Reference Missions (DRM's) representing the majority of likely customers. The DRM-1 supports assembly of the Space Station, while DRM-2 supports deployment of other payloads. In a sample DRM-1A launch, a Station lab module and node are launched into an orbit 250 nautical miles high where they wait up to two weeks for a manned Shuttle with other Station elements. In DRM-2, Shuttle-C carries a Centaur upper stage and a heavy planetary spacecraft. These are placed in a parking orbit before departure, or injected from a high suborbital trajectory flown by Shuttle-C.

Candidate Payloads

Many payloads have been studied as possible Shuttle-C customers. Although most are not currently funded or approved projects, they illustrate the utility of this vehicle. A sampling (with possible launch dates) includes:

Space Station—Assembly and resupply missions (1995-post 2000).

Transportation Development—Advanced Solid Rocket Motor initial launch (1994), Upgraded Space Shuttle Main Engine (1996), Space Transportation Main Engine (1997), Liquid Rocket Booster (1998); some with TBD payloads.

Planetary Missions—Comet Rendezvous/Asteroid Flyby (1994), Cassini (Saturn orbiter/probes, 1996), Mars Rover/Sample Return (1998), Solar Probe (solar surface flyby, 1998), Comet Nucleus Sample Return (1999).

Space Science and Applications—Advanced X-ray Astrophysics Facility (1995), Earth Observing System polar platform (1996), Space Infrared Telescope Facility (1998), Geostationary Orbit Platform (2000), Mobile Satellite C (2001).

Department of Defense—Zenith Star (Strategic Defense Initiative demonstration, 1995), other DOD payloads (1996-post 2000).

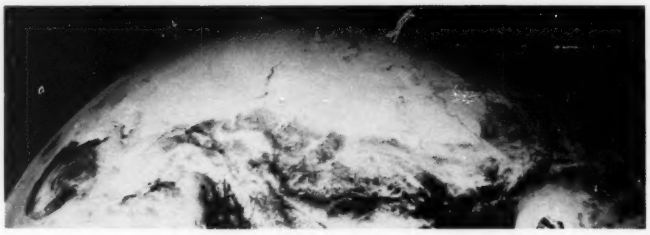
Shuttle-C helps answer the call for U. S. leadership in space.■

> It is an appropriate competitor for the Soviet Energia and the French Ariane 5 heavy-lift launch vehicles... which the U.S. can develop in the near term within reasonable cost and risk.

Science Agencies Announce Arctic Ozone Investigation

Two federal science agencies, the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA), have announced a cooperative investigation to better understand the nature of potential depletion of stratospheric ozone over the Arctic.

During January and February, scores of scientists from NASA, NOAA and nearly a dozen other research organizations will carry out an airborne study similar to that done last year on Antarctic ozone depletion. That study directly implicated man-made chlorofluorocarbons (CFCs) as a cause of the "ozone hole" over Antarctica in the austral spring, and raised the question whether a similar phenomenon could be occurring in the Arctic, perhaps on a reduced scale.



Earlier this year, in smaller, separate field investigations, NASA and NOAA found elevated levels of chlorine compounds in the atmosphere over the Arctic, giving urgency to this Arctic joint study.

"NASA Headquarters has organized the expedition and is providing overall mission management and support through its Upper Atmosphere Research Program, while NOAA's Aeronomy Laboratory is providing project science management," according to NASA's Dr. Robert Watson, the chief program manager.

The planned Airborne Arctic Stratospheric Expedition will fly specially instrumented NASA ER-2 and DC-8 aircraft into the Arctic vortex from Jan. 1 through Feb. 15, 1989.

The timing of the flights coincides with the statistically most active period for the formation of extremely low-temperature polar stratospheric clouds there. Such clouds are involved in the complex processes that result in the destruction of stratospheric ozone in the Antarctic polar vortex.

"The investigation will search for ozone-depletion processes within the Arctic vortex and their possible influence on ozone concentrations over heavily-populated northern mid-latitudes. If even a small fraction of the Antarctic loss is occurring in the Arctic," it could more than double the predicted high-latitude ozone depletion," said Dr. Daniel L. Albritton, director of NOAA's Aeronomy Laboratory, Boulder, Colorado.

Scientists and engineers will be stationed at Stavanger, Norway, for the duration of the aircraft flights. Additionally, in related activities, personnel from NOAA's Geophysical Monitoring for Climatic Change Program will be launching balloon-borne ozone sonde instruments from Barrow, Alaska; Canadian scientists will fly similar instruments from Alert, Northwest Territories; and NASA scientists will launch balloon ozone sondes from Lerwick, U.K. and assist the Danish Meteorological Institute in conducting similar experiments from Greenland to provide additional ozone information about the Arctic. Related and coordinated balloon experiments also will be flown from Heiss Island by Soviet scientists; from Bear Island by Norwegian scientists; and from Spitsbergen by the Federal Republic of Germany.

Meteorological data from NASA's Nimbus 7 satellite, from various NOAA and European weather satellites and from ground stations will be coordinated with aircraft flights and aircraft data through a sophisticated real-time data network provided by NASA. The British Meteorological Office will use complex computer modeling to look at data from a given region of air and predict how that region will evolve over a period of days.

ER-2 and DC-8 flight sampling of the air mass on subsequent days will test the validity of the computer model.

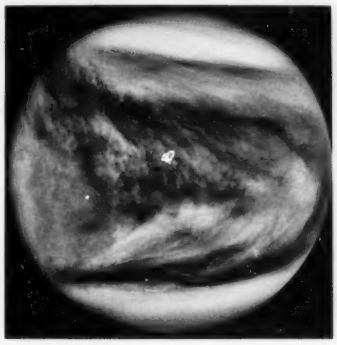
An additional team of theorists will be supporting these activities by providing real-time chemical and dynamical modeling using the preliminary aircraft results to refine subsequent flight strategies.

The aircraft will have largely independent but complementary scientific instruments. The ER-2 is scheduled to fly approximately 10 separate missions from Stavanger, on the western coast of Norway over the Arctic to about 80

continued on page 16

Pioneer Orbiter's 10 Years Have Revealed Much About Venus

The Pioneer orbiter spacecraft has passed the decade mark for years circling Earth's cloud draped twin planet, Venus. Pioneer has continuously returned pictures of the planet and much other data and is still going strong.



On Dec. 9, it was also 10 years since a companion spacecraft, Pioneer Venus 2, entered Venus' atmosphere along with four hard impact probes it released. The five probes measured the atmosphere from top to bottom on the planet's day and night sides and in its northern and southern hemispheres.

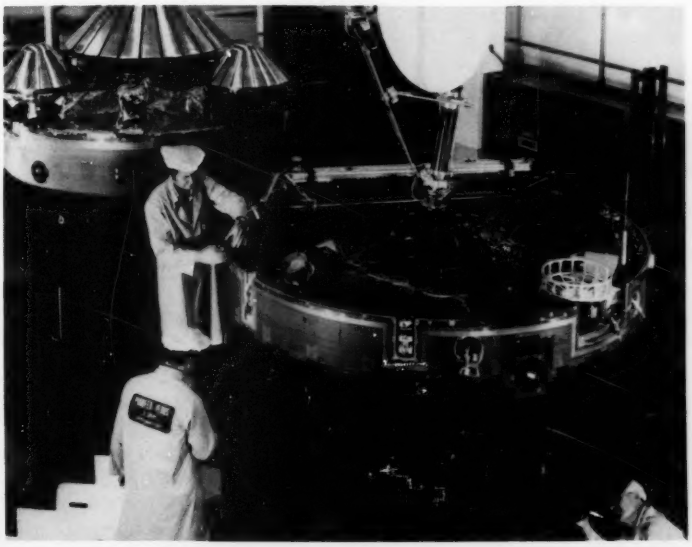
Though other spacecraft have visited Venus, Pioneer's imminent completion of 3,652 24-hour-long orbits of Venus represents the first and most thorough survey of the planet yet made.

The orbiter, its five sister probe craft, the 26 scientific instruments they carried and the more than 100 scientists and over 200 project people making up the Pioneer team have achieved much together. They have mapped 93 percent of the planet, finding high mountains, plains and deep canyons. Previously, almost nothing was known about Venus' surface features.

They found that almost rotationless Venus, with a day eight months long, has no magnetic field. They established the framework for calculating the processes of Venus' interior. This seems to show that to have an interior "dynamo mechanism" and resulting magnetic field, a planet must have the centrifugal force provided by rapid rotation, acting on its molten interior.

They verified and quantified the "runaway greenhouse" effect that makes the planet somewhat hell-like, hotter on the surface than the melting points of lead and zinc (900 degrees Fahrenheit). They directly measured the planet's heavy cloud cover with 10 years of pictures from the spacecraft. They found a nine-mile-thick layer of "smog" piled atop the clouds and they found that the planet was incredibly dry. Pioneer data suggest that Venus had oceans 3.5 to 4 billion years ago.

Pioneer's orbit around Venus is changing slowly as solar gravity moves Pioneer's orbital low point closer to the planet. The spacecraft's orbit will continue changing until late August 1992, when Pioneer will enter Venus' dense lower atmosphere and burn up. During its last six months, the spacecraft will be only about 90 miles from the planet, and scientists will be looking for such things as visible evidence of Venusian lightning. ■



Above: Venus from Pioneer Venus Orbiter.
Right: Technicians at Ames Research Center prepare Pioneer Venus Orbiter for its scientific mission investigating Venusian atmosphere and weather. The multiprobe companion spacecraft is in the background.

CENTER HIGHLIGHTS

Grand Opening Gives Glimpse of JSC's Future

By Pam Alloway, JSC

Balloons, colored lights and a jazz band whose snappy music soared to Bldg. 9B's 75-foot high ceiling heralded the grand opening of the newly constructed Space Station Mockup and Trainer Facility.

"Welcome to Building 9B and welcome to this glimpse of our future in space," JSC Deputy Director Paul J. Weitz told the crowd. "This is a momentous day not only for JSC but for the agency and the program."

Clarke Covington, manager of the Space Station Projects Office, also spoke to the crowd and stressed the importance of integrating the space station with other existing training programs.

"This is a major milestone designed to be operational for at least 30 years," Covington said.

The opening of 9B marks the first in a line of new facilities JSC plans to open in the next few years, Covington said. Other new construction will include a trainer in Bldg. 5, an expanded control center in Bldg. 30 to monitor the space station, and a second addition to Bldg. 9 that will house equipment and controls for verification of the engineering and assembly of the space station in orbit. Future plans also call for a neutral buoyancy building that will replace the Weightless Environment Training Facility and enclose 12.5 million gallons of water.

The 9B building addition encompasses 21,250 square feet in the high bay area and 6,000 square feet of technical support area.

Prime contractor was Valcon 2 Inc. The addition cost about $3.5 million and the mockup and trainers cost about $1.3 million, said John Trebes, manager of the Space Station Mockup and Trainer Facility.

The 9B mockup consists of five modules: a logistics module that will store space station supplies but which has not yet been constructed in 9B; a U.S. laboratory module; a crew habitation module designed to house a crew of up to eight people; a Japanese laboratory module; and an ESA laboratory module.

The mockup also includes four connecting resource nodes that will house command and control equipment, provide extra storage space and serve as airlocks between docking vessels and the modules. Two of the nodes have an elevated cupola—one for celestial viewing and one for viewing the Earth. In the cupolas, crew members will have a 360-degree field of vision enabling them to operate various manipulating equipment.

In addition to the logistics module, workers will construct a Crew Escape and Return Vehicle (CERV) mockup in Bldg. 9B at a later date.

The Space Station Training Facility support contractor is Johnson Engineering Corporation. Space station work package contractors are: McDonnell Douglas; Lockheed (LESC); Rockwell International; and Bendix Field Engineering.

NASA officials began planning for the housing of a space station mockup and trainer in 1984. Construction of Bldg. 9B began in May 1986 and workers in late September moved the space station mockups into 9B.

Crews will begin training in the mockups two years before NASA launches the first flight carrying space station materials, Trebes said. Crew training in the modules could begin by 1993 according to current projections.

Astronaut Story F. Musgrave describes Space Station activities to a news crew in front of a mockup of modules of Freedom. Ceremonies opening Bldg. 9B facility drew attention of the media, as well as employees at Johnson Space Center.

Kuiper Airborne Observatory Continues Supernova Studies

Results from NASA's C-141 Kuiper Airborne Observatory (KAO) recent supernova expeditions are helping to create a detailed picture of the birth of matter in one of nature's most powerful events.

The Kuiper team has completed its fourth deployment to observe Supernova 1987A, continuing its studies of charged (ionized) particles, and mass and ejection velocities of heavy metals produced in the giant blue star's explosion, first observed in February 1987.

The November 1988 mission found nickel, argon, and iron exploding outward at 868 miles per second, the same high speeds first observed on the KAO's third supernova expedition in April of this year. Scientists also observed expected decreases in ionization and brightness levels of the explosion.

An anomalous red shift, or scattering of light, was again seen, but at a reduced level. This phenomenon had been predicted for astronomical objects, and first observed on the KAO's third mission. The effect is produced by argon and nickel photons interacting with electrons torn (by the shock wave) from hydrogen originally on the surface of the star.

The five-week KAO study conducted from Christchurch, New Zealand was headed by mission Manager James McClenahan. The KAO carried four experiments and accommodated more than 20 scientists. The Ames Research Center, Mountain View, Calif., led collaboration included short infrared wavelength investigations by Principal Investigators Fred Witteborn with Jesse Bregman, Diane Wooden, Dave Rank, Tim Axelrod, and Martin Cohen. Longer infrared wavelength studies were conducted by Ames Principal Investigator Ed Erickson with Mike Hass, Sean Colgan and Steve Lord.

Previous Kuiper observations of the expanding ejected cloud have greatly contributed to understanding how the explosion proceeds. The first detections of nickel, argon, iron, and radioactive cobalt produced in the SN 1987A core were made by the Kuiper crew's second mission in November, 1987. Abundances and velocities of nickel, argon and iron formed in the core were first measured on the third mission in April 1988.

The prevailing theory, supported by recent observations, states that supernovae are the great chemical factories in the universe, creating and hurling into interstellar space most of the elements heavier than carbon.

The collapse of a massive star is the only naturally occurring event with pressures and temperatures great enough to fuse heavier elements. Stars with masses of eight to 40 times that of our sun explode immediately after they collapse, forming supernovae.

A great shock wave, produced by the nuclear force, moves away from the core and collides with matter falling inward at a slower speed. The shock wave produces the heavy elements by rapid fusion, and blows the remaining layers of the star into interstellar space. The Kuiper experimenters have been tracking the newly-formed elements in this ejected cloud.

Heavier stars may form black holes upon collapsing, while lighter stars, like the sun, end their lives less violently-as white dwarfs. Before exhausting its fuel, Supernova 1987A spent most of its 10 million years as a hot blue giant in the Large Magellanic Cloud, 170,000 light years away. The Large Magellanic Cloud is the Milky Way's nearest galactic neighbor. At the time of its cataclysmic collapse, the star (catalogued by Sanduleak) was 20 times the mass of our sun.

The Kuiper Airborne Observatory recently returned from a fourth mission to study Supernova 1987A. The Kuiper allows celestial observations unhampered by low altitude air and light pollution.

Stars spend most of their lives fusing hydrogen into helium in the cores. During this long middle age, the star is relatively stable-the inward pull of gravity caused by its immense mass, and the radiant pressure of its core, provided by

continued on page 12

Kuiper
from page 11

thermonuclear reactions (fusion), are about equal. After the hydrogen core is completely converted to helium, the newly-created helium core temporarily collapses under gravity. If the star is large enough, increased heat and pressure ignite a second stage of thermonuclear production, now fueled by helium.

Helium then burns to carbon and oxygen. During this period, the star's outer surface cools and expands, and the star becomes a red giant. Once helium fusion ceases, contraction occurs again, and the core grows hotter. This process is repeated, forming heavier materials, until iron is produced in the central core.

The protons and neutrons of iron are in the most stable arrangement possible and, at this stage, nucleosynthesis ceases. The iron core is eventually overcome by tremendous forces of gravity-until, at a very small distance the nuclear force reverses (repels rather than attracts) and a nuclear bounce and explosion occurs.

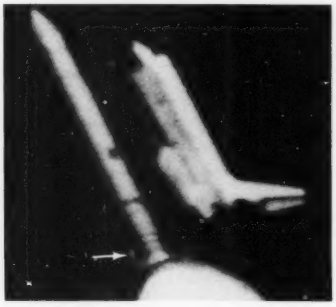
The high densities present during the iron core collapse squeeze electrons and protons together to form neutrons. Enormous quantities of invisible neutrinos, emitted in the production of neutrons, were detected here on Earth during a 10 second period on February 23, 1987.

Kuiper Airborne Observatory Supernova 1987A research is conducted by the Astrophysics Branch, Space Science Division, at Ames and supported by the Ames Science and Applications Aircraft Division. Overall program management and funding comes from the Astrophysics Division, Office of Space Science and Applications, NASA Headquarters. ■

Reverse Flow In Shuttle Plume is Old Hat to Marshall Center Group

As tracking cameras followed the Space Shuttle Discovery downrange during its Sept. 29 ascent into orbit, many spectators experienced a wave of apprehension. Beginning approximately a minute and a half into the flight, they noticed that the plume of flames and exhaust behind the shuttle seemed to have spawned an additional flame slightly above the base of one solid rocket booster.

Lee Foster, an aerospace engineer in one of the Marshall Space Flight Center's specialized laboratories was also watching Discovery's flight on a TV monitor in



96 seconds into flight, plume recirculation is discernable in this STS-5 Columbia launch.

the Huntsville Operations Support Center. He noticed the small outgrowth from the main plume, too. Instead of being alarmed, though, Foster watched with high interest. He had expected to see the flames.

To Foster and his coworkers in the Aerophysics Division of the Structures and Dynamics Laboratory, the effect captured by tracking cameras is a familiar one. In fact, their studies of it long ago resulted in giving the phenomenon a name ("plume recirculation") and establishing it as the subject of a unique engineering discipline.

Plume recirculation, Foster explained, is due to the relative location of the booster and main engine nozzles, the expansion of the rocket jets at high altitudes, and the airflow around the Shuttle vehicle and its plumes.

"As the Shuttle ascends, atmospheric pressure becomes lower," Foster said. "As a result, the exhaust plumes grow wider as the Shuttle gains altitude. Then, as they get wider, they begin to intersect with each other and this intersection region gets closer and closer to the base region of the vehicle.

Foster said usually around 92 seconds the high temperature gases heat the aft dome of the external tank and the aft sections of the boosters. "Around the outer boundary of the recirculation region, oxygen from the airflow around the Shuttle mixes with some of the recirculated exhaust gases, allowing residual fuel in the plume to burn. That's what results in the flames seen in the flight videotapes," said Foster.

Foster said it is not a safety issue because the heating effect from plume recirculation was calculated even before the first Shuttle flight and appropriate thermal protection has always been used to protect the flight hardware.

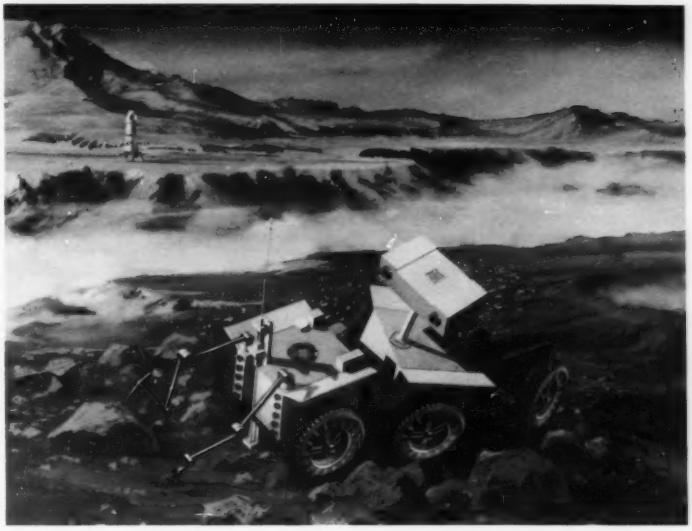
"We've been building our data base on this subject ever since the mid-1960's. In fact, plume recirculation occurred from the very beginning, even with the German V-2 rockets. During the first six flights of the Shuttle, we put a variety of gauges on the external tank and boosters to measure the heating from plume recirculation," said Foster. "These measurements showed that the heating was basically the same on each flight and that the vehicle is well protected from the heating." ■

Q&A

The following questions and answers are excerpted from interviews conducted for NASA's radio program, "The Space Story."

Smart Machines in Space

Imagine computers able to think like people—to fly space ships, learn new skills, make their own decisions. Not only can NASA scientist Donald Rosenthal imagine them, he and others at the Ames and Goddard Research Centers are getting ready to build them. One might drive a soil sampler on the Martian surface; another might fly an orbiting tanker and refuel earth satellites. Rosenthal describes them as expert systems.



One concept for a Mars rover.

Q What makes a smart machine smart or an expert system expert?

A According to Rosenthal, "The main characteristic of an expert system is that it takes the hard won reasoning ... the hints and kinks of a human expert...experience that has been garnered over many, many years... takes those reasoning processes and encodes them as a set of special case rules that given the right data, can operate together."

Q Will we then have computers like HAL, of the movie "2001: A Space Odyssey" fame? A computer that can run every aspect of a spacecraft's operation?

A "...Love to be able to see within my lifetime a computer that would be capable of the things that HAL was capable of...coming up with new ideas for interpretation of information, totally autonomously.

We're still on the range of pushing blocks around in order to achieve very, very small tasks."

Scientists continue to focus on building machines that are very smart—but only in very specific ways. First they define bases of knowledge that describe the decision making processes behind a complex operation. They then try to transfer that knowledge to the computer. Now being constructed is a knowledge base for a Mars rover—how to interpret what is seen through the lens of a camera and from other sensors to make a trip across the surface safer and more productive. Because of the time delay between when communicating between Earth and Mars, a rover must be able to take care of itself.

Q If not as smart as HAL, how autonomous and self-caring can our rover with its smart computer be?

A Says Rosenthal, "...there is hardly the opportunity to send large amounts of data back to be analyzed on Earth before you tell the rover its next task. So a lot of the work has to be done "in situ" on board the rover itself without intervention from the Earth and that's what we've been looking at.

"It's our intention to show that entire scenario, including the decision-making, can be automated... can be done without intervention from the ground, so that you can, on your own, find interesting sites; take cores and analyze the cores. And when the next opportunity for communication with the ground comes along, you will be able to say, 'Hey guys, we drilled five cores, here's the mineralogy from those; two of them show carbonates and there's a trace of organics in one of them. I suggest we take this one home.'" ■

NASA NEWS CAPSULES

News Capsules are NASA news releases edited by the Internal Communications Branch, Office of Communications.

NASA Selects 86 Small Business Research Proposals

NASA has announced selection of 86 research proposals for negotiation of contracts in NASA's Small Business Innovation Research (SBIR) program. These include 25 proposals for phase I SBIR projects from the 1988 program solicitation and 61 proposals for phase II follow-on contracts for completed phase I projects.

Awards will be made to 76 small business firms in 19 states.

The 25 phase I award selections add to the 202 selections made in November, making a total of 227 phase I selections chosen from the 2,379 proposals received in the 1988 program. The 61 phase II award selections make up the first of two groups of contracts to be awarded for continuations of phase I projects chosen in the 1987 program. The total number of phase II awards is expected to exceed 90 and will be chosen from an estimated 180 phase II proposals from phase I contractors. The second group will be selected in February 1989.

NASA, LTV Sign Commercial Agreement for Scout Rocket Production

The National Aeronautics and Space Administration and the Missiles Division of LTV Missiles and Electronics Group, Dallas, Texas, have announced the signing of an agreement which grants the firm exclusive rights to commercially produce and market the Scout launch vehicle.

NASA's successful negotiation of the agreement marks another important advance in establishing a strong U.S. commercial launch vehicle industry through the privatization of government expendable rocket programs.

Under the agreement, LTV is granted rights to produce and launch the Scout on a commercial basis and is provided with access to and use of NASA-controlled production tooling and special test equipment required to manufacture the Scout.

The agreement also enables LTV to obtain access to and use of Scout launch support facilities at the NASA Wallops Flight Facility, and at Vandenberg Air Force Base.

Four Space Shuttle Crews Named

Astronaut flight crews have been named to four Space Shuttle missions which are scheduled to fly in late 1989 and early 1990, bringing the total number of crews in training to nine.

Col. Frederick D. Gregory (USAF) will command STS-33, a Department of Defense mission aboard Discovery set for Aug. 10, 1989. Gregory's crew members will consist of pilot S. David Griggs and mission specialists F. Story Musgrave, M.D., Kathryn C. Thornton, Ph.D. and Capt. Manley L. "Sonny" Carter, Jr., M.D. (USN).

The Space Shuttle Atlantis will fly under the command of Capt. Donald E. Williams (USN) on Oct. 12, 1989, on mission STS-34. Williams and crew will deploy the planetary probe Galileo, sending it on its way to Jupiter. The pilot for the mission is Cmdr. Michael J. McCulley (USN). Shannon W. Lucid, Ph.D., Ellen S. Baker, M.D. and Franklin R. Chang-Diaz, Ph.D., have been named as mission specialists.

Capt. Daniel C. Brandenstein (USN) will command the STS-32 crew aboard Columbia. The mission, scheduled for Nov. 13, 1989, will feature deployment of the Syncom IV-5 satellite and retrieval of the Long Duration Exposure Facility. Lt. Cmdr. James D. Wetherbee (USN) will serve as pilot. Bonnie J. Dunbar, Ph.D., G. David Low and Marsha S. Ivins have been named as mission specialists.

Shuttle mission STS-35 will feature the ASTRO-1 astronomy laboratory and is scheduled to fly March 1, 1990. Commanding the mission aboard Columbia is Capt. Jon A. McBride (USN). Col. Guy S. Gardner (USAF) has been named as pilot. Mission specialists are John M. "Mike" Lounge, Jeffrey A. Hoffman, Ph.D., and Robert A.R. Parker, Ph.D.

Payload specialists named to the ASTRO-1 mission are Ronald A. Parise, Ph.D. and Samuel T. Durrance, Ph.D. Durrance and Parise were assigned previously to fly with ASTRO-1 in March 1986 on mission STS 61-E.

Satellite Booster to be Replaced

The Intertial Upper Stage first stage motor for STS-29 was damaged December 1 during pre-launch processing at Cape Canaveral Air Force Station, Florida.

The Air Force and NASA have decided to replace the first stage motor with a spare motor already available at the launch site.

The Air Force and NASA have determined the incident will have no impact on the planned February 18, 1989, launch date.

HUMAN FACTORS

Hlass Appointed to Headquarters Post, Estess to Direct Stennis Space Center

Hlass

Estess

Dr. James C. Fletcher, NASA administrator, has named Stennis Director Jerry Hlass for the post of assistant for engineering and technology to the deputy administrator, NASA Headquarters, and Roy S. Estess, currently deputy director of Stennis Space Center, to succeed Hlass as director.

In his new assignment, Hlass will provide engineering and technology assessment to top agency management across the entire spectrum of NASA programs. Since 1976, he has directed all aspects of the Stennis mission, including support of Space Shuttle main engine and orbiter main propulsion system testing; research and technology development in Earth and environmental system sciences and observations; cooperative commercialization of remote sensing with industry and universities; and technology development and applications in propulsion test operations.

Estess has been deputy director of the Stennis Space Center since 1980 and has held various progressively responsible engineering and management positions, including manager of advanced Shuttle test facility planning, applications engineering and the regional remote sensing applications program.

Moser Named Deputy Associate Administrator for Space Station

The selection of Thomas L. Moser as deputy associate administrator for Space Station has been announced by James B. Odom, head of the Space Station Office, NASA Headquarters.

Moser succeeds Dr. Franklin D. Martin, who recently was appointed assistant administrator for exploration.

Moser served as director of the Space Station Freedom program in Reston, Va., a post he held since the program office's inception in October 1986. In that position, he was responsible for the technical content, schedule and budget for the Space Station Freedom program.

Pedersen Appointed AA for External Relations

The appointment of Kenneth S. Pedersen as associate administrator for external relations has been announced by Dr. James C. Fletcher, NASA administrator.

In his new position, Pedersen will be responsible for the agency's congressional, intergovernmental, international and industry relations; educational activities and relations with educational institutions and the NASA History Office.

Pedersen has served as deputy associate administrator since September 1986. During the previous 6-1/2 years, he was director of NASA's International Affairs Division, with responsibility for coordinating NASA interface with international organizations and foreign governments.

The new head of NASA's External Relations Office was selected in 1983 and 1988 for Presidential Meritorious Rank Awards. He was a Fulbright Fellow in Denmark from 1966 to 1967, and has authored numerous articles on European politics and space subjects, in addition to co-editing a book on Western European governments.

Pedersen headed the U.S. government delegation to the U.N. Committee on the Peaceful Uses of Outer Space on three occasions (1979 through 1981). He also was a member of the U.S. delegation to the U.N. Unispace Conference in August 1982.

Finarelli Appointed Deputy AA

Margaret G. Finarelli has been appointed deputy associate administrator for External Relations.

In this position, Finarelli will support the associate administrator for External Relations in the areas of policy level management, direction and coordination of the agency's relationships with public and private organizations, both domestic and international. This includes other Executive Branch agencies, the Congress, state and local governments, foreign governments, international agencies, industry and private individuals.

She has served as NASA's representative on the Senior Interagency Group (Space) working groups which developed the President's Space Station decision, the National Space Strategy and the Shuttle pricing decision.

Since 1986, she has been director of the Policy Division in the Office of Space Station.

Arctic Ozone

from page 8

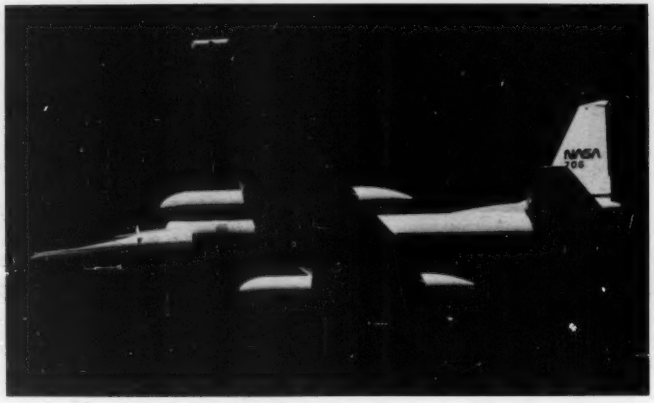
degrees North Latitude and then return. This flight plan allows substantial penetration of the Arctic vortex. The DC-8, which has a vastly longer range and could fly further north to the pole, is expected to fly as many times as the ER-2.

Several flights of the ER-2 and DC-8 will be flown simultaneously to allow for complementary sets of data to be acquired at the same time.

Following each flight, data from the experiments will be used along with satellite and ground station data to plan the next flights. This will enable the scientists to optimize their flights for existing atmospheric conditions.

The ER-2 is a highly modified U-2 high-altitude Earth resources and atmospheric research airplane. It will fly in the region of expected maximum ozone depletion up to 65,000 feet and carry instruments designed to provide information on three-dimensional winds, pressure, temperatures and temperature profiles. Other ER-2 instruments will directly sample the chemical composition including the chlorine oxide radical, the bromine oxide radical, ozone, nitrous and nitric oxide, the total amount of water, methane and several CFCs and samples of condensation nuclei (particulates which would cause condensation to occur) and cloud particles.

The DC-8 is a modified version of the commercial DC-8. It has been retrofitted with high-bypass-ratio turbofan engines and its interior cabin space has been modified into a flying laboratory for Earth resources and atmospheric remote sensing research. It will fly in the lower portion of the ozone depletion region at altitudes up to 40,000 feet and carry instruments to measure ozone and aerosol profiles, chlorine dioxide, bromine oxide radical, nitric acid, chlorine nitrate, nitrogen oxides as well as hydrochloric acid using both whole air sampling and remote sensing techniques.



The ER-2 research aircraft will fly in expected ozone depletion areas at altitudes of up to 65,000 ft.

The experiments not only have been designed to determine the extent of existing Arctic ozone depletion but also to provide for a wide base of high quality atmospheric data.

Although the data from the various experiments will undergo preliminary analysis in Stavanger, the rigorous analysis and modeling of the data will not be done until completion of the aircraft experiment. At the end of the aircraft experiments, the science team will prepare a summary statement of observations and new findings.

Various scientific teams will work towards providing a rigorous and fairly complete analysis of their data by late summer 1989. At that time it is expected that the different science teams will meet to compare analyses and interpretations. A preliminary interpretation of the findings is expected to be available to the scientific community around August of next year.

Dr. Adrian Tuck of NOAA's Aeronomy Laboratory is the project scientist. Personnel from NASA's Ames Research Center, Moffett Field, Calif.; Jet Propulsion Laboratory, Pasadena, Calif.; Goddard Space Flight Center, Greenbelt, Maryland; and the Langley Research Center, Hampton, Va. also will participate.

Aircraft operations and management are being provided by NASA's Ames Research Center.

Additional project and scientific support is being provided by the National Science Foundation's National Center for Atmospheric Research; the Chemical Manufacturers Association; Harvard University; the University of Denver; Pennsylvania State University; the United Kingdom Meteorological Office; the University of Cambridge, UK; the University of Oslo, Norway; Kernforschungsanlage (KFA) in Julich, FRG; and the Danish Meteorological Institute. ■